Airborne Topographic Lidar Report

Wisconsin WROC – 3DEP
Menominee County Lidar 2020

Prime Contractor: Ayres

Airborne Lidar Acquisition:
Quantum Spatial, an Nv5 Company

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1. Summary / Scope

1.1 Summary

This report contains a summary of the WROC 2020 Menominee County lidar acquisition task order, issued by Ayres Associates Inc. under Task Order 54 that was executed on January 21, 2020. The task order yielded a project area covering approximately 399 square miles over Menominee County in Wisconsin. The intent of this document is only to provide specific validation information for the data acquisition/collection, processing, and production of deliverables completed as specified in the task order.

1.2 Scope

Aerial topographic lidar was acquired using state-of-the-art technology, along with the necessary surveyed ground control points (GCPs) and airborne GPS and inertial navigation systems. The aerial data collection was designed with the following specifications listed in Table 1 below.

Table 1. Originally Planned Lidar Specifications

AVERAGE POINT DENSITY	FLIGHT ALTITUDE (AGL)	FIELD OF VIEW	MINIMUM SIDE OVERLAP
2 pts / m²	2180 m	40°	30%

1.3 Coverage

The project boundary covers approximately 399 square miles over Wisconsin. Project extents are shown in Figure 1.

1.4 Duration

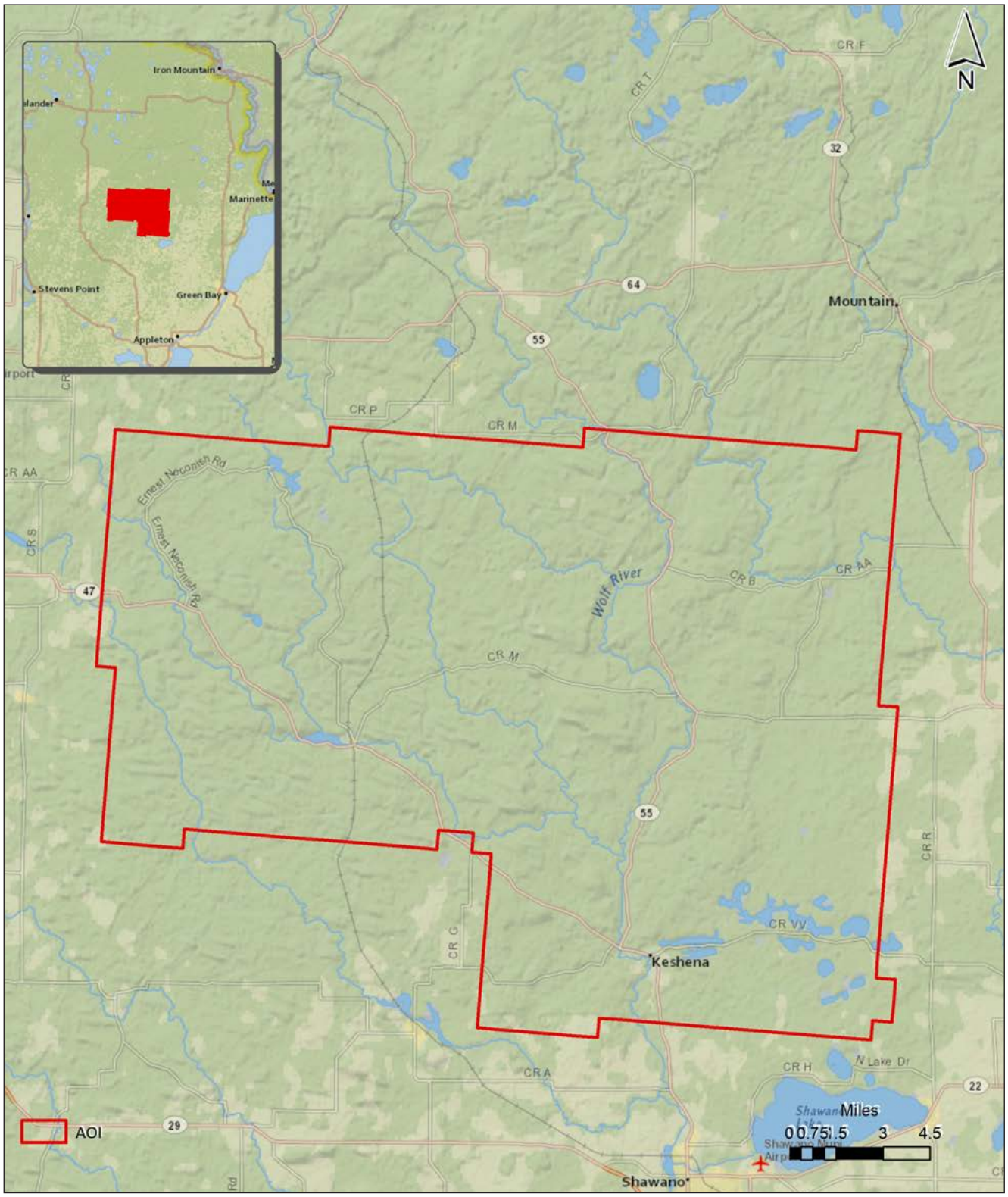
Lidar data was acquired from April 25, 2020, to April 30, 2020, in two lifts. See “Section: 2.4. Time Period” for more details.

1.5 Issues

There were no major issues to report for this project.

WROC 2020 MENOMINEE COUNTY – DELIVERABLES PROJECTED COORDINATE SYSTEM: WISCRS MENOMINEE COUNTY HORIZONTAL DATUM: NAD83 (2011) VERTICAL DATUM: NAVD88 (GEOID 12B) UNITS: U.S. SURVEY FEET
• One copy of lidar tiled point cloud data in LAS format on external hard drive
• All flight mission parameters appropriate for inclusion in FGDC/USGS compliant metadata

Figure 1. Menominee County Project Boundary



2. Planning / Equipment

2.1 Flight Planning

Flight planning was based on the unique project requirements and characteristics of the project site. The basis of planning included: required accuracies, type of development, amount/type of vegetation within project area, required data posting, and potential altitude restrictions for flights in project vicinity.

Detailed project flight planning calculations were performed for the project using Leica MissionPro planning software. The entire target area was comprised of 32 planned flight lines (Figure 2).

2.2 Lidar Sensor

Quantum Spatial used a Leica ALS80 lidar sensor (Figure 3), serial number 8239, for lidar collection.

The Leica ALS80 system is capable of collecting data at a maximum frequency of 1,000 kHz. The system uses a Multi-Pulse in the Air option (MPIA). The sensor also has the capacity for unlimited range returns from each outbound pulse. The intensity of the returns is also captured during aerial acquisition.

A brief summary of the aerial acquisition parameters for the project are shown in the Lidar System Specifications in Table 2.

Figure 2. Menominee County Planned Flight Lines

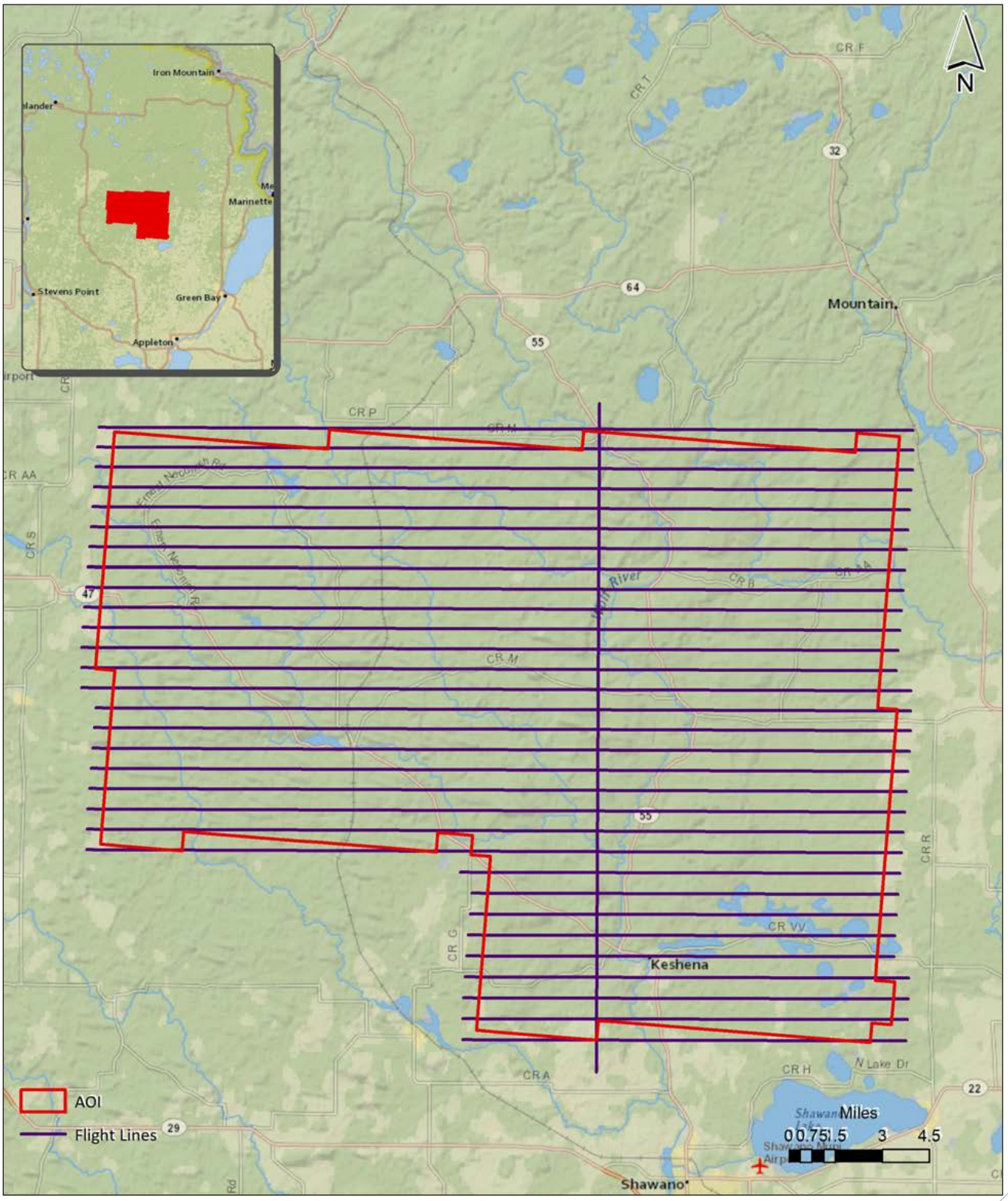


Table 2. Lidar System Specifications

		LEICA ALS80
Terrain and Aircraft Scanner	Flying Height	2180 m
	Recommended Ground Speed	160 kts
Scanner	Field of View	40°
	Scan Rate Setting Used	41.2 Hz
Laser	Laser Pulse Rate Used	380.2 kHz
	Multi Pulse in Air Mode	3
Coverage	Full Swath Width	1586.91 m
	Line Spacing	1470.71 m
Point Spacing and Density	Average Point Spacing	0.6 m
	Average Point Density	2.9 pts/m²

Figure 3. Leica ALS80 Lidar Sensor

2.3 Aircraft

All flights for the project were accomplished through the use of a customized plane. The plane type and tail number are listed below.

Lidar Collection Planes

- Cessna Caravan, Tail Number(s): N22TE

This aircraft provided an ideal, stable aerial base for lidar acquisition. This aerial platform has relatively fast cruise speeds, which are beneficial for project mobilization/demobilization while maintaining relatively slow stall speeds, proving ideal for collection of high-density, consistent data posting using a state-of-the-art Leica ALS80 lidar system. Some of Quantum Spatial's operating aircraft can be seen in Figure 4 below.

Figure 4. Some of Quantum Spatial's Planes

2.4 Time Period

Project-specific flights were conducted between April 25, 2000, and April 30, 2000. Two aircraft lifts were completed. The accomplished lifts are listed below.

- 04252020 (SN8239, N22TE)
- 04302020 (SN8239, N22TE)

3. Processing Summary

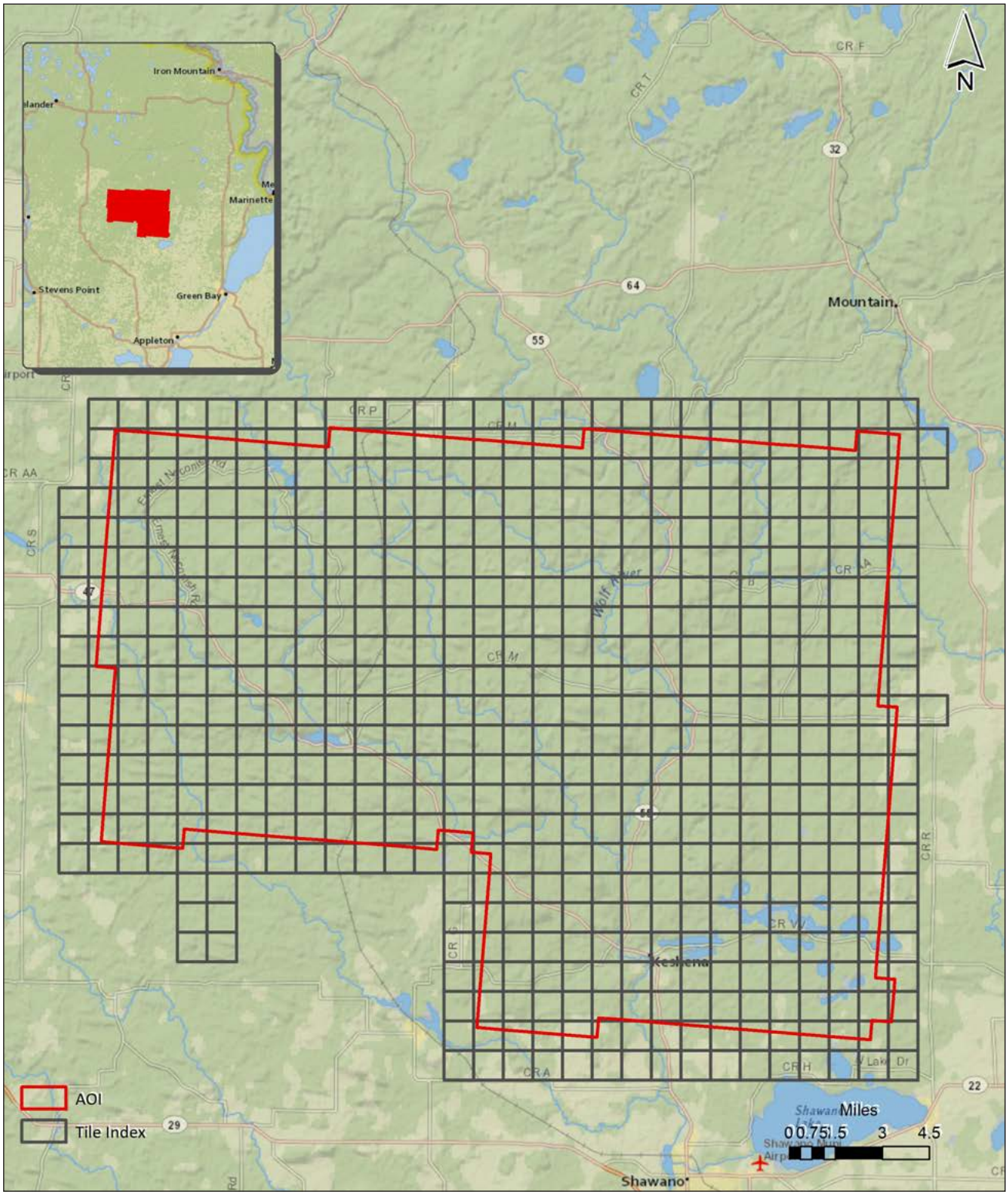
3.1 Lidar Processing

Leica Inertial Explorer software was used for post-processing of airborne GPS and inertial data (IMU), which is critical to the positioning and orientation of the lidar sensor during all flights. Inertial Explorer combines aircraft raw trajectory data with stationary GPS base station data yielding a "Smoothed Best Estimate Trajectory" (SBET) necessary for additional post processing software to develop the resulting geo-referenced point cloud from the lidar missions.

During the sensor trajectory processing (combining GPS & IMU datasets), certain statistical graphs and tables are generated within the Inertial Explorer processing environment, which are commonly used as indicators of processing stability and accuracy. This data for analysis include: Max horizontal/vertical GPS variance, separation plot, altitude plot, PDOP plot, base station baseline length, processing mode, number of satellite vehicles, and mission trajectory.

Point clouds were created using the Leica CloudPro software. The generated point cloud is the mathematical three-dimensional composite of all returns from all laser pulses as determined from the aerial mission. The point cloud is imported into GeoCue distributive processing software. Imported data is tiled and then calibrated using TerraMatch and proprietary software. Using TerraScan, the vertical accuracy of the surveyed ground control is tested, and any bias is removed from the data.

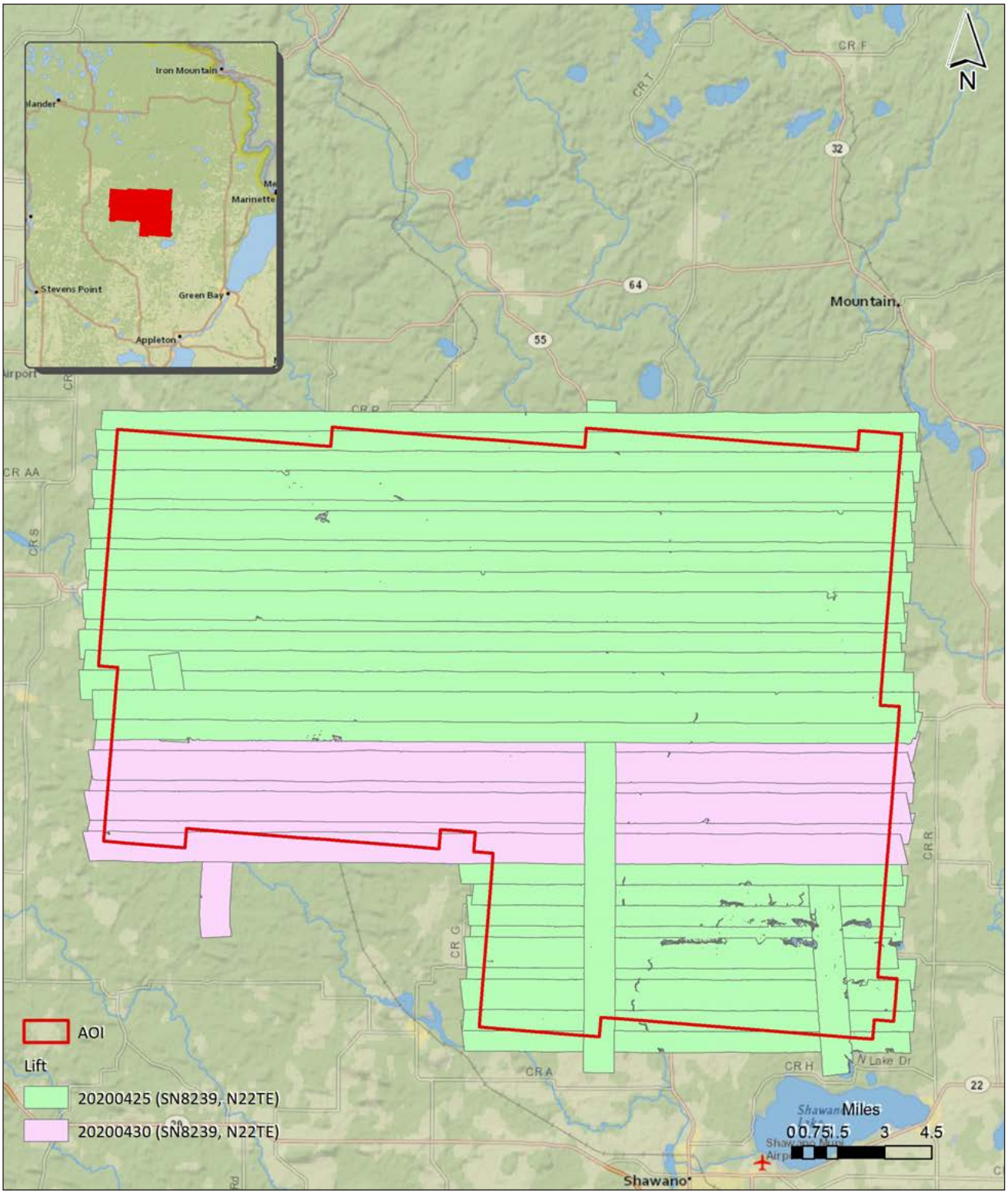
Figure 5. Lidar Tile Layout



4. Project Coverage Verification

Coverage verification was performed by comparing coverage of processed .LAS files captured during project collection to generate project shape files depicting boundaries of specified project areas. Please refer to Figure 6.

Figure 6. Lidar Flight Line Coverage



5. Ground Control and Check Point Collection

Quantum Spatial used 21 ground control (calibration) points collected by Ayres.

5.1 Calibration Control Point Testing

Figure 7 shows the location of each bare earth calibration point for the project area. TerraScan was used to perform a quality assurance check using the lidar bare earth calibration points. The results of the surface calibration are not an independent assessment of the accuracy of these project deliverables, but the statistical results do provide additional feedback as to the overall quality of the elevation surface.

Figure 7. Calibration Control Point Locations

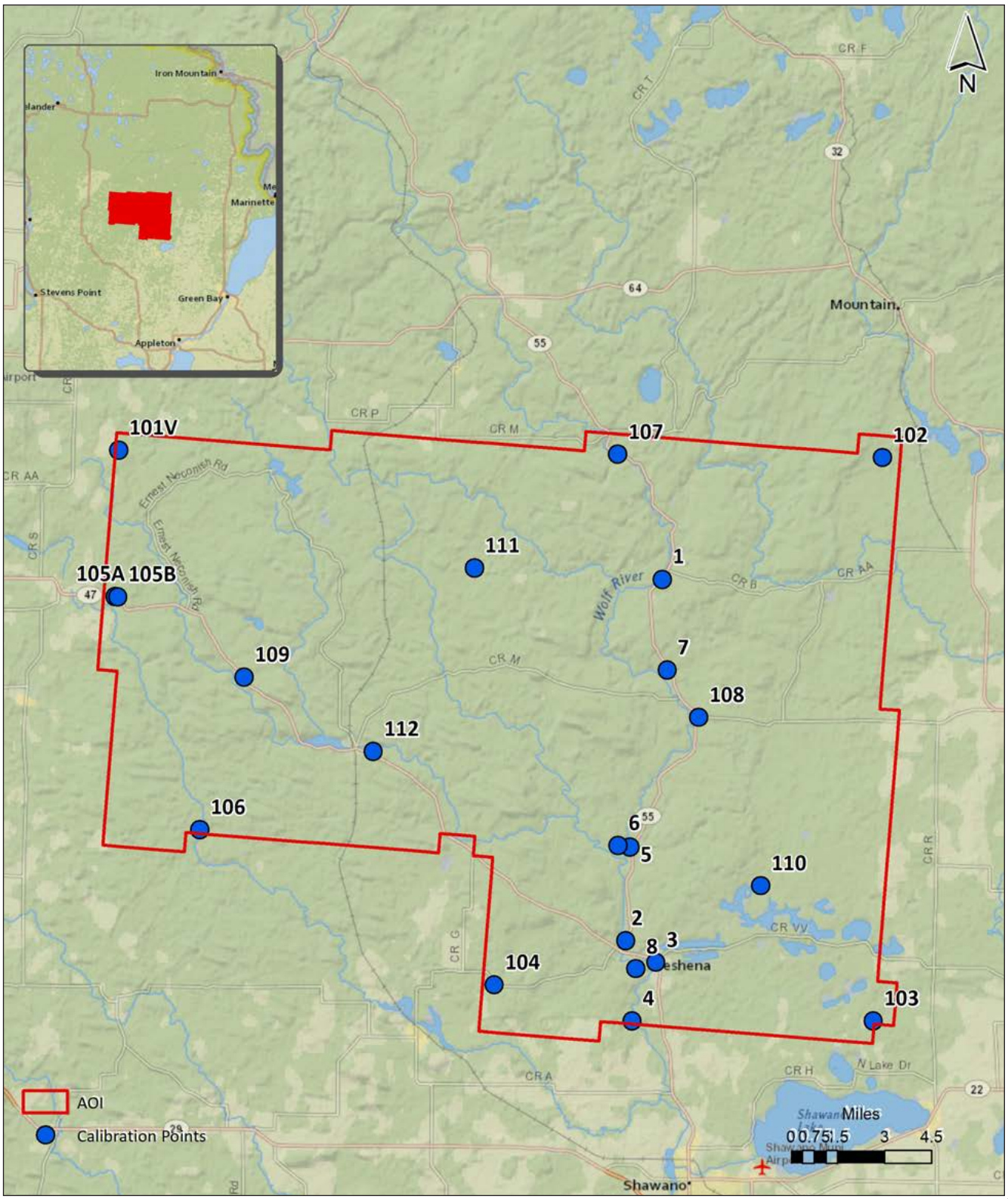


Table 3. Calibration Control Point Report
Units = U.S. survey feet

NUMBER	EASTING	NORTHING	KNOWN Z	LASER Z	DZ
1	291484.769	125146.217	997.689	997.66	-0.029
2	285306.6	64181.272	858.749	858.67	-0.079
3	290419.589	60549.577	847.311	847.22	-0.091
4	286416.866	50699.214	866.004	866.03	0.026
5	286022.468	79979.981	880.727	880.71	-0.017
6	284035.539	80269.025	877.488	877.51	0.022
7	292305.505	109849.03	960.858	960.78	-0.078
8	287021.664	59443.321	867.395	867.32	-0.075
101V	199818.302	146844.377	1430.921	1430.97	0.049
102	328580.624	145582.807	898.747	898.95	0.203
103	327089.426	50687.142	855.451	855.38	-0.071
104	263163.885	56724.209	909.285	909.38	0.095
105A	199228.115	122278.743	1291.979	1291.71	-0.269
105B	199698.423	122213.338	1284.085	1284.05	-0.035
106	213487.799	82934.721	1126.104	1126.11	0.006
107	283947.263	146176.602	1085.006	1084.95	-0.056
108	297633.908	101899.657	924.025	924.09	0.065
109	220947.253	108675.524	1214.529	1214.62	0.091
110	308101.797	73504.383	856.532	856.64	0.108
111	259800.917	126990.768	1141.444	1141.49	0.046
112	242751.073	96160.278	1049.16	1049.32	0.16

Average Dz	0.003
Minimum Dz	-0.269
Maximum Dz	0.203
Average Magnitude	0.080
Root Mean Square	0.101
Std Deviation	0.104